Accident and Emergency Nursing (2003) **11,** 106–111
0965-2302/03/$ - see front matter
doi:10.1016/S0965-2302(02)00189-3

Snake bite in Australia: first aid and envenomation management

Carmel J. Stewart

Australia is inhabited by a large variety of snakes, including some of the most poisonous in the world. Sightings are regular, and the incidence of snake bite is estimated to be several thousand a year. A bite does not necessarily result in envenomation occurring, however there are at least 300 snakebites a year requiring treatment of envenomation, with between 1 and 4 fatalities every year. The incidence of fatalities from snake bite has increased over recent years. The explanation for this is unclear, but possible reasons include the urban sprawl, and a delay in application of appropriate first aid and definitive treatment for envenomation. Emergency nurses in particular should be aware of the first aid techniques appropriate for Australian snake bite, as well as the recognition and management of envenomation. This article will outline the steps required and rationale for applying first aid techniques considered to be effective in retarding spread and circulation of snake venom. It will also discuss the manifestations that indicate systemic envenomation, and management considered to be responsible for reducing the incidence of death from snake envenomation in Australia.

Carmel J. Stewart
BNsg (Hons), CCN, RN, Coordinator and Lecturer Emergency Nursing and Critical Care Nursing, Department of Nursing and Midwifery RMIT University Bundoora,
PO Box 71,
Bundoora 3083,
Melbourne,
Australia

Tel.: +61-3-9925-7546; Fax: +61-3-9467-5286;
E-mail: carmel.stewart@rmit.edu.au

Manuscript received: 20 July 2002; *accepted:* 12 September 2002

Snakebite season in Australia

Australia's climate and proximity of national parks to major metropolitan areas provides opportunity for a range of outdoor activities. There is also an extensive rural population involved in agricultural and farming activities outside the metropolitan areas. Australians have a reputation for enjoying our extensive beaches, surf, mountains, rivers, and bush as part of their normal work and recreational activities. These opportunities are heavily promoted in local and overseas travel and holiday advertising. As a result, many Australian residents and visitors do take advantage and enjoy the opportunities whenever possible. However the outdoor life is shared with a variety of creatures with the potential for harm. These include spiders, such as the funnel web spider, a variety of marine creatures, and snakes. This article will focus on the first aid and emergency management of snakebite and snake envenomation in the Australian environment.

Snakebite in Australia

Australia is inhabited by a large variety of snakes, many of which are amongst the most poisonous in the world. Snake activity is minimal during the cooler winter months, but as summer advances, and warm weather appears, people start to move their activities to the outdoors, and so do the snakes. Snakes are not confined to the rural areas of Australia. Snakes are regularly sighted (Harman 1999;

Sprivulis & Jelinek 2000), and residents and visitors of metropolitan areas may experience snake bite and possible envenomation. In recent years, the incidence of snake bites and fatalities from snake bites have increased (AVRU 2000). The explanation for this is unclear, but may be due to the urban sprawl, and a delay in application of appropriate first aid and definitive treatment (Sprivulis & Jelinek 2000). The actual incidence of snakebite in Australia is estimated to be several thousands each year, with approximately 300 recorded cases requiring antivenom administration (AVRU 2000). The incidence of deaths from snakebite is estimated to be between 1 and 4 a year (AVRU 2000; Sprivulis & Jelinek 2000; White 1998). The inaccuracy of information related to the incidence of snakebite and death from envenomation is attributed to the possibility of unrecognised snakebite and envenomation (AVRU 2000). For this reason, emergency nurses should consider any patient presenting with a suspected snakebite as having been bitten by a snake until proven otherwise. The potential for snakebite exists in metropolitan, regional, and rural areas, and hence emergency nurses in all areas need to have a heightened awareness of the possibility, and to be aware of first aid and envenomation recognition and management.

Australian snakes and their venom

There are over 140 recognised snakes in Australia (Shea 1999). Not all of these are venomous, and those that are (and represent those that are known to have caused envenomation in the human population) may be grouped into six main groups of brown snake, tiger snake, copperhead, black snake, taipan, and death adder (Shea 1999; White 1998). These large varieties of snakes inhabit known geographical areas. For example, the taipan is a highly venomous and aggressive snake that inhabits the northern parts of Australia, and will not naturally be found in the southern regions, and the death adder can be found in all regions except Victoria and Tasmania (AVRU 2000; Shea 1999). The copperhead is a cool climate snake, and inhabits the southern states of Australia, including Tasmania, as are tiger snakes (AVRU 2000; Shea 1999). There have been recordings of tiger snakes in small numbers in parts of warmer Queensland, however they are more common in Tasmania and other southern areas (Shea 1999). Knowledge of the usual geographical habitat for particular snakes is useful in that it can assist in identifying the snake involved in a bite and envenomation.

The major effects of Australian snake venom include neurotoxins that result in a general paralysing effect, coagulation abnormalities of increased clotting and anticoagulation, myolitic activity resulting in muscle breakdown and subsequent renal failure, and a direct nephrotoxic effect (AVRU 2000; Sprivulis & Jelinek 2000; White 1998). A local cytotoxic effect may occur at the bite site, however this is not a major effect of Australian snake venom (AVRU 2000; Sprivulis & Jelinek 2000; White 1998).

The various snakes may exhibit only one or two of these effects, and to varying degrees. For example, the brown snake venom is attributed to having a direct nephrotoxic effect, while the venom of the tiger and taipan may cause renal failure secondary to rhabdomyolysis from the myolitic effect of their venom (Sprivulis & Jelinek 2000). Consumptive coagulopathies have been attributed to the venom of taipan, brown, tiger snakes (Sprivulis & Jelinek 2000; White 1998) and the black snake (White 1998). Note that individual snake species do not exert only one toxic effect. Several have components of neurotoxins, haemotoxin (including anti- and procoagulant effects), myotoxin and nephrotoxin effects, although they vary in potency from one snake to another. For example the taipan has potent neurotoxic and hence paralysing effects, with only weak haemotoxic and coagulant effects (Evans-Murray & Foster 1996). The brown snake has been attributed to having highly potent coagulant effects requiring a significant increase in the amount of antivenom required to reverse the effects (AVRU 2000; Sprivulis & Jelinek 2000).

As all snakes within a group contain similar toxins in their venoms, it has been possible to develop specific antivenoms. The reduction in death due to snake bite since the beginning of

the 20th century is attributed in part to the development of these antivenoms (Sprivulis & Jelinek 2000). However, Australian snake venom may exert its effects rapidly (White 1998), and limiting the spread of the venom away from the bite site is also an important aspect in the reduction of morbidity and mortality due to snake envenomation (AVRU 2000; Sprivulis & Jelinek 2000).

First aid

First aid techniques have been credited with reducing the fatalities associated with snakebite in Australia (AVRU 2000; Sprivulis & Jelinek 2000). Snake venom is circulated through the body via the lymphatic system, and the pressure-immobilisation-bandage or PIM Bandage is effective in reducing systemic envenomation (Sprivulis & Jelinek 2000). This is a technique that should optimally be employed at the time and scene of the snakebite. However, this is not always the case, and victims of bites may present for treatment of snakebite with no first aid for a variety of reasons, that anecdotal information indicates includes panic, and lack of knowledge of first aid techniques. As part of the management of snakebite, first aid interventions should be applied as early as possible, including on presentation to the emergency department (Sprivulis & Jelinek 2000). Hence application of the PIM bandage is a priority in the triage intervention of a possible snake bite victim.

Further highlighting the need for application of the PIM bandage immediately on presentation to the emergency department is the considerable time that is required to assess the victim, identify that envenomation has occurred and the type of snake involved, and organise and administer antivenom. The time required to achieve these aims, and any intervening delays, increases the possibility of systemic distribution of the venom. For example, the most reliable way to identify the type of snake involved, and hence administer the most appropriate antivenom is through using the venom detection kit. This however takes 25 min to obtain a result (White 1998). Further explanation for the need to apply a PIM bandage on arrival in the emergency department will be discussed with the administration of antivenom.

The PIM bandage includes the application of a splint to reduce movement of the limb where the bite has been inflicted. In addition to this, it is highlighted that immobilising the patient is an important measure to reduce the spread of the venom (AVRU 2000; Sprivulis & Jelinek 2000). This means that under all circumstances, transport (including wheelchairs or trolleys) are bought to the patient, rather than having the patient walk. It is also important not to wash the site, as venom at the bite site is used to assist in snake identification.

Application of the pressure-immobilisation bandage

The PIM bandage aims to compress tissues surrounding the bite, and hence slow lymphatic circulation of the venom. The PIM bandage is designed for snakebites to the limbs, as these are the most common sites (AVRU 2000). Local pressure should be applied to bites to the head, neck, and torso (AVRU 2000). Sprivulis and Jelinek (2000) suggest the use of adrenaline injected into the site to retard the spread of venom.

The following technique of administration of the PIM bandage was originally developed by Struan Sutherland, and has been recommended as first aid for snake bite since 1979 (Sutherland 1981).

1. Identify the site of the bite from the victims' subjective account. It is not always possible to identify fang marks. The absence of any mark does not exclude the possibility of snakebite–suspicion must remain high.
2. From the bite site apply a compression bandage to the digits (leaving tips exposed to allow for monitoring of circulation), and then back to the top of the limb. This is appropriate if the patient is only a short time from definitive treatment. If the patient has yet to be transported considerable distance, the bandage will be better tolerated if applied from the digits upwards (AVRU 2000). Although this carries a risk of pushing venom away from the site, the risk is considered minimal (AVRU 2000). Crepe bandages are commonly available and

suitable for applying adequate compression. The bandage is not to act as a tourniquet, and should be applied to a firmness appropriate for a sprained ankle, and should be selected with the size of the limb taken into consideration, for example a 10 cm bandage is appropriate for the lower limb of an adult.

3. Do not wash or clean the site prior to application, as this will remove traces of venom required for snake and antivenom identification. A small window can be cut in the bandage at the bite site to take a venom swab. A mark on the outside of the bandage, placed at the time of application, can assist in identifying the appropriate site for the window.
4. A splint should be applied to keep the limb immobilised, and the patient placed in a position of rest.
5. This bandage should remain in place until the possibility of envenomation has been excluded, or an infusion of antivenom has been commenced

Identifying the snake involved

It is necessary to identify if a snakebite has occurred, and as a separate responsibility, identify if envenomation of the victim has occurred. Fang marks are not always left after a snake has bitten. There may be a scratch, or it may not be possible to identify any marks at all (AVRU 2000). In this case it is necessary to rely on the patients description of where the bite occurred. It is important to realise that this does not exclude the possibility of snakebite, and assessment and management of envenomation needs to continue.

Even if a snake does bite, it does not always inject venom, adequate venom to cause envenomation, or inject venom into the tissues (AVRU 2000). A Venom Detection Kit (VDK), developed by the Commonwealth Serum Laboratories under the guidance of the late Struan Sutherland, is used to identify the type of snake, and the antivenom to be used in the case of envenomation. This test is considered highly reliable (White 1998). The VDK is more reliable than visual identification of the snake, as snake appearance alters with seasonal changes. Much identification is based on scale shape and size rather than overall colour and markings and requires an experienced herpetologist to distinguish one type of snake from another (AVRU 2000). Visual identification of the snake often requires the snake to be killed, and this practice increases the danger and probability of snake bite, angers the snake and increases the danger of envenomation, and is an illegal act as snakes in Australia are a protected species under the Nature Conservation Act 1980 (Environment ACT 2000).

Swabs of the site, and if systemic symptoms are present, urine, is combined with the solutions and vials as directed by written instructions supplied with the VDK. The results will inform clinicians of the type of antivenom that will be effective. Blood is not recommended for use in the VDK as it can give misleading results in the form of false positives and false negatives (Sprivulis & Jelinek 2000; White 1998).

Identifying envenomation

If venom has been identified through the VDK, it is then necessary to determine if the patient has been envenomated. Many patients, although certainly bitten by a snake do not experience envenomation (Sprivulis & Jelinek 2000). This will possibly have already been determined by the frequent assessment that will have been continuing throughout the venom identification process. Victims should be observed for signs of paralysis or paraesthesia, such as blurred vision, slurred speech. These are symptoms associated with the neurotoxins found in many of Australia's snakes, but may also be due to myotoxin activity (White 1998). Other tests include a full blood examination and clotting profile to identify abnormalities associated with haemotoxins. Physical assessment may reveal bruising or oozing of blood from small wounds or mucous membranes (White 1998). Urea, creatinine, electrolytes, and creatinine kinase should also be evaluated for signs of effects of toxins on renal function and muscle breakdown. Any variation from normal identified in frequent assessments should be considered as a sign of envenomation.

Patients may also experience nausea, vomiting, abdominal pain, headache, dizziness, or sweating. However in the absence of signs of paralysis or laboratory data, these manifestations cannot be considered as indications of envenomation (Sprivulis & Jelinek 2000).

Administering antivenom

Once systemic signs of envenomation have been identified, the patient is administered antivenom as an antidote. The antivenom of choice is indicated by the VDK, and supplies of appropriate antivenom should be maintained in hospitals within the known geographic snake habitats. These patients should be managed in an area fully equipped with resuscitative equipment.

In some cases there may be inadequate venom swabbed from the site, or the venom may not have been excreted into the urine to allow the VDK to identify the snake involved, but signs of envenomation are identified. In other cases, systemic envenomation may be obvious and severe, and hence it is inappropriate to delay administration of antivenom (White 1998). In these cases, because of the known habitat regions, and similarities of toxins within the venom, guidelines exist for the type of antivenom to be administered.

The Australian Venom Research Unit recommends: in Tasmania, administration of tiger snake antivenom; in Victoria, administration of tiger snake and brown snake antivenom; in all other areas, polyvalent antivenom is required to cover the range of snakes that may have inflicted the bite (AVRU 2000).

The antivenom is administered in a diluted form via infusion. Administration of the antivenom is clearly outlined in the product information insert. These should be carefully read and adhered to. Allergic reaction, including anaphylaxis, to the antivenom is possible as it is produced from horse serum, however this is reported as being a rare occurrence (AVRU 2000; Sprivulis & Jelinek 2000). To counteract this, the infusion should be commenced slowly, and can be increased to the required rate if the patient displays no signs of allergic response (AVRU 2000). Other measures to prevent an allergic response are the administration of prophylactic adrenaline and promethazine (Sprivulis & Jelinek 2000). These measures are controversial as it is considered the adverse effects outweigh the potential beneficial effects, and there have been reports of allergic reactions occurring despite these measures (White 1998). As a result of this controversy, administration of prophylactic medications is left to individual physician discretion. White (1998) reports that a survey revealed that prophylaxis for allergic responses is rarely used.

The PIM bandage should not be removed until the infusion has commenced to prevent worsening of systemic symptoms, and possible worsening of the victims' clinical state. For the antivenom to be effective, it needs to come in contact with the circulating venom. Therefore, once the antivenom infusion has been commenced, the bandage can be removed. At this time the patient requires close and observant monitoring as the release of venom may overwhelm the infused antivenom. Any deterioration in the victims' condition may be an indication of worsening envenomation, and replacement of the PIM bandage should be undertaken. This will slow any further release, and allow the antivenom to act against the circulating venom. Improvement and stabilisation of the victims' condition indicates that the PIM bandage can again be released. This process is continued until the PIM bandage has been completely removed, and the patient remains stable, and signs of envenomation improve. Transfer to the intensive care unit is then appropriate for any patient who has displayed signs of envenomation, if this has not already occurred.

It should be noted, that there is no limit to the amount of antivenom required. This is guided by the victims' clinical condition, and there is no maximum or limit to the dose for either adults or children.

Absence of envenomation

Very few patients will experience envenomation despite receiving a snakebite. In these patients appropriate treatment involves removal of the PIM bandage under close

observation in an area fully equipped with resuscitative equipment. Repeat blood tests should be taken and evaluated one hour after removal of the bandage. If there is no change in the patients condition or laboratory reports, the patient may be moved to an observation area for close monitoring and repeat blood tests at 6 and 12 h (Sprivulis & Jelinek 2000). In the absence of indications of envenomation over the 12 h period, it is suitable to discharge the well patient to home.

Conclusion

Snakebite remains a prevalent hazard in the Australian environment, although envenomation from snake bite has a relatively low incidence. Despite this, there has been a concerning increase in death from snake bite in recent years. This has been attributed to the inappropriate first aid management and lack of recognition of snake bite and envenomation. Emergency nurses need to be aware of the possibility of patients presenting with snakebite, the first aid measures required to minimise systemic envenomation, and the assessment and treatment required for these patients.

A guiding principle in the initial management of snakebite is to assume there has been a snakebite and envenomation until proven otherwise. Venom detection kits and awareness of clinical manifestations of envenomation will guide the appropriate administration of antivenom to counteract the effects of Australian snake venom.

References

AVRU, 2000. Australian Venom Research Unit. University of Melbourne http://www.pharmacology.unimelb.edu.au/pharmwww/avruweb/index.htm Snakebite in Australia last updated 14/12/2000. (accessed 11th July 11, 2002)

Environment ACT, 2000. http://www.environment.act.gov. au/ie4/petsandlocalwildlife/livingwithsnakes.html accessed 11th July 2002)

Evans-Murray A, Foster M 1996 Snake bite – an occupational hazard. Australian Critical Care 9(3): 88–91

Harman A 1999 Confronting deadly biters. Law and Order October: 88–90

Shea GM 1999 The distribution and identification of dangerously venomous Australian terrestrial snakes. Australian Veterinarian Journal 77(12): 791–798

Sprivulis P, Jelinek G 2000 Toxicology – Snakebite. In: Cameron et al., (eds). Textbook of Adult Emergency Medicine. Churchill Livingstone, Edinburgh pp. 649–652

Sutherland S 1981 In: Venomous Creatures in Australia. Oxford University Press, Melbourne pp. 8–9

White J 1998 Envenoming and antivenom use in Australia. Toxicon 36(11): 1483–1492